

# Recent $B$ Physics Results from CDF

Robert Harr

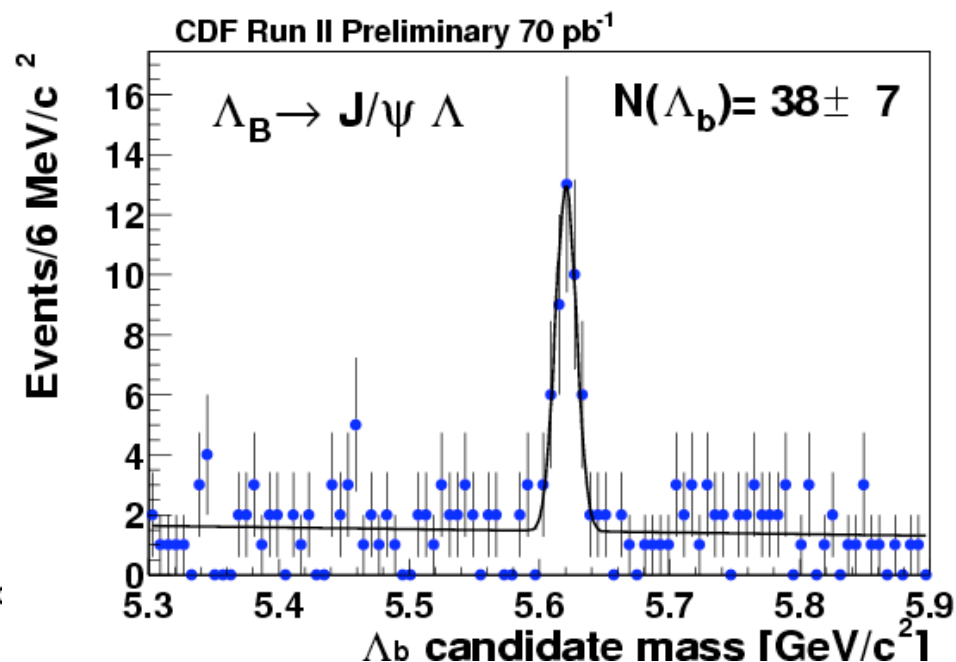
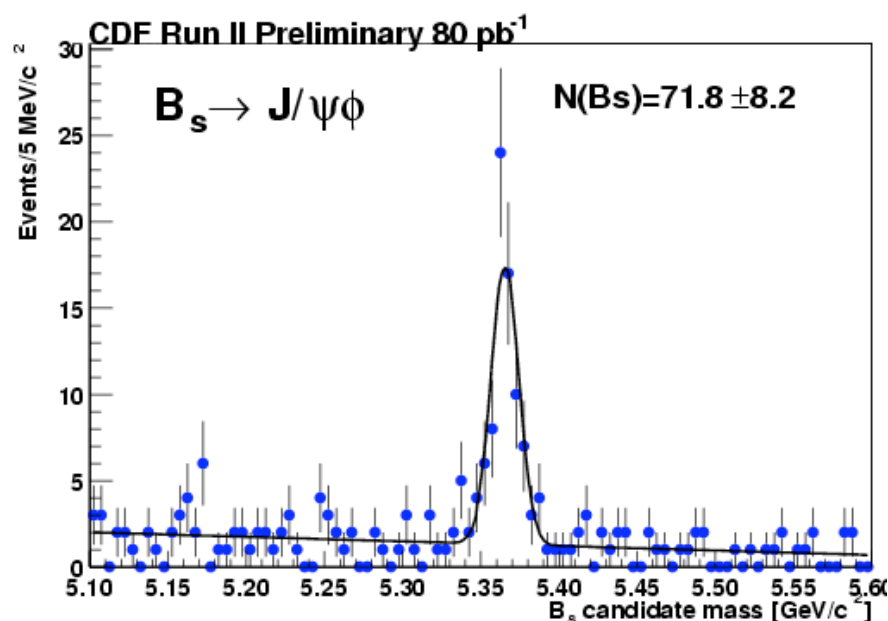
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# Recent $B$ Physics Results from CDF

Using up to  $220 \text{ pb}^{-1}$  of data

- Masses and lifetimes
  - A prelude to CP measurements
- Rare decays
- Observation of the state  $X(3872)$
- Hadronic  $B$  decay final states are collected with the displaced track trigger
  - $B_s$  mixing channel
  - Access to CP angles  $\alpha$  and  $\beta$

# B Hadron Masses



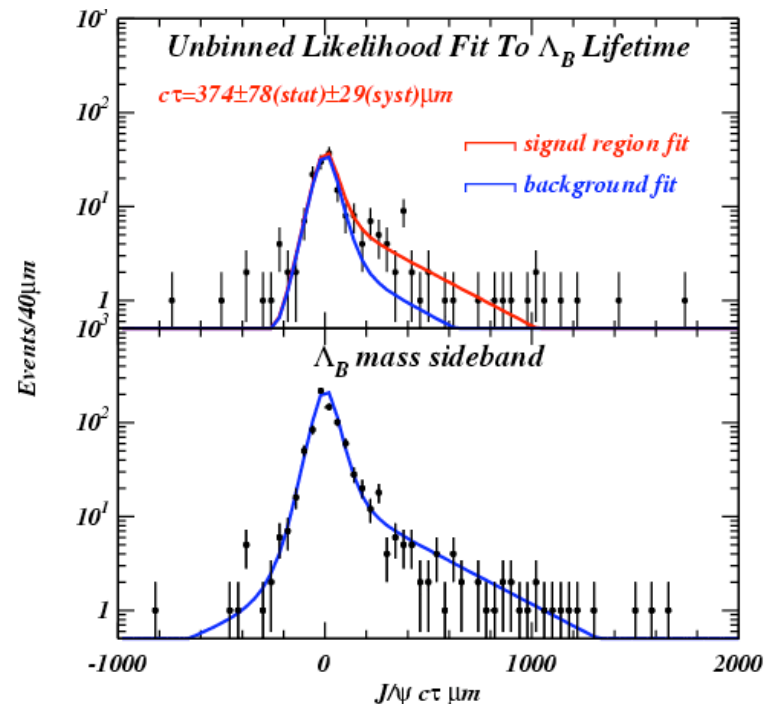
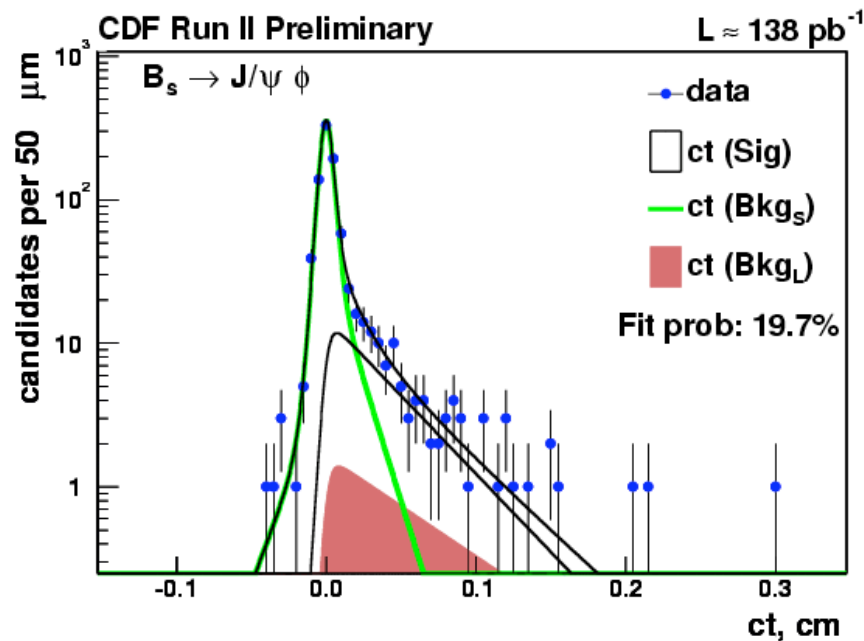
🌀 Competitive measurements for  $B_d$  and  $B^+$ :

$M(B_d) = 5280.30 \pm 0.92 \pm 0.96$  MeV and  $M(B^+) = 5279.32 \pm 0.68 \pm 0.94$  MeV

🌀 World's best measurements for  $B_s$  and  $\Lambda_B$ :

$M(B_s) = 5365.50 \pm 1.29 \pm 0.94$  MeV and  $M(\Lambda_B) = 5620.4 \pm 1.6 \pm 1.2$  MeV

# B Hadron Lifetimes

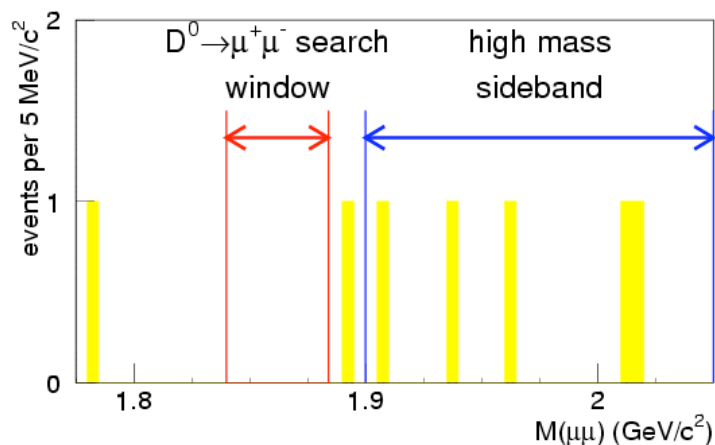
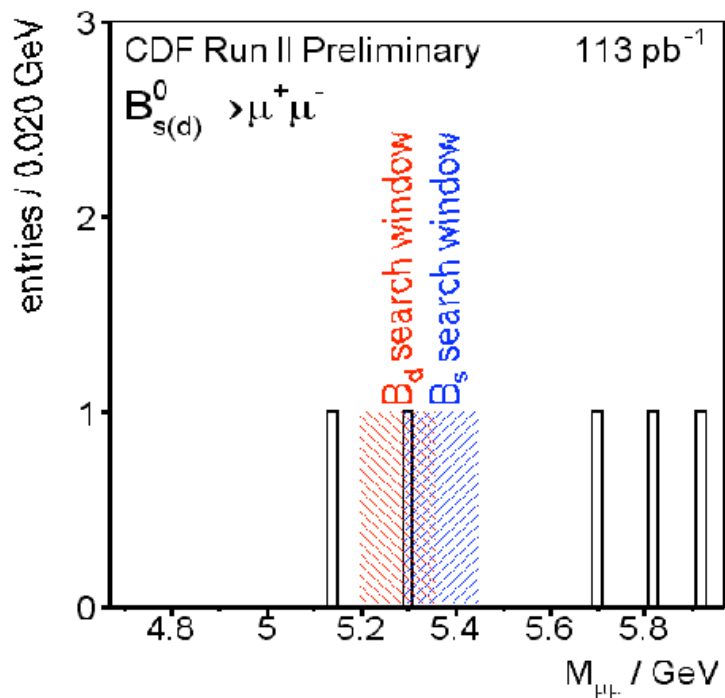


- Check  $B_d$  and  $B^+$  lifetimes against BaBar/Belle measurements.

$$\tau(B_s) = 1.33 \pm 0.14 \pm 0.02 \text{ ps and } \tau(\Lambda_B) = 1.25 \pm 0.26 \pm 0.10 \text{ ps}$$

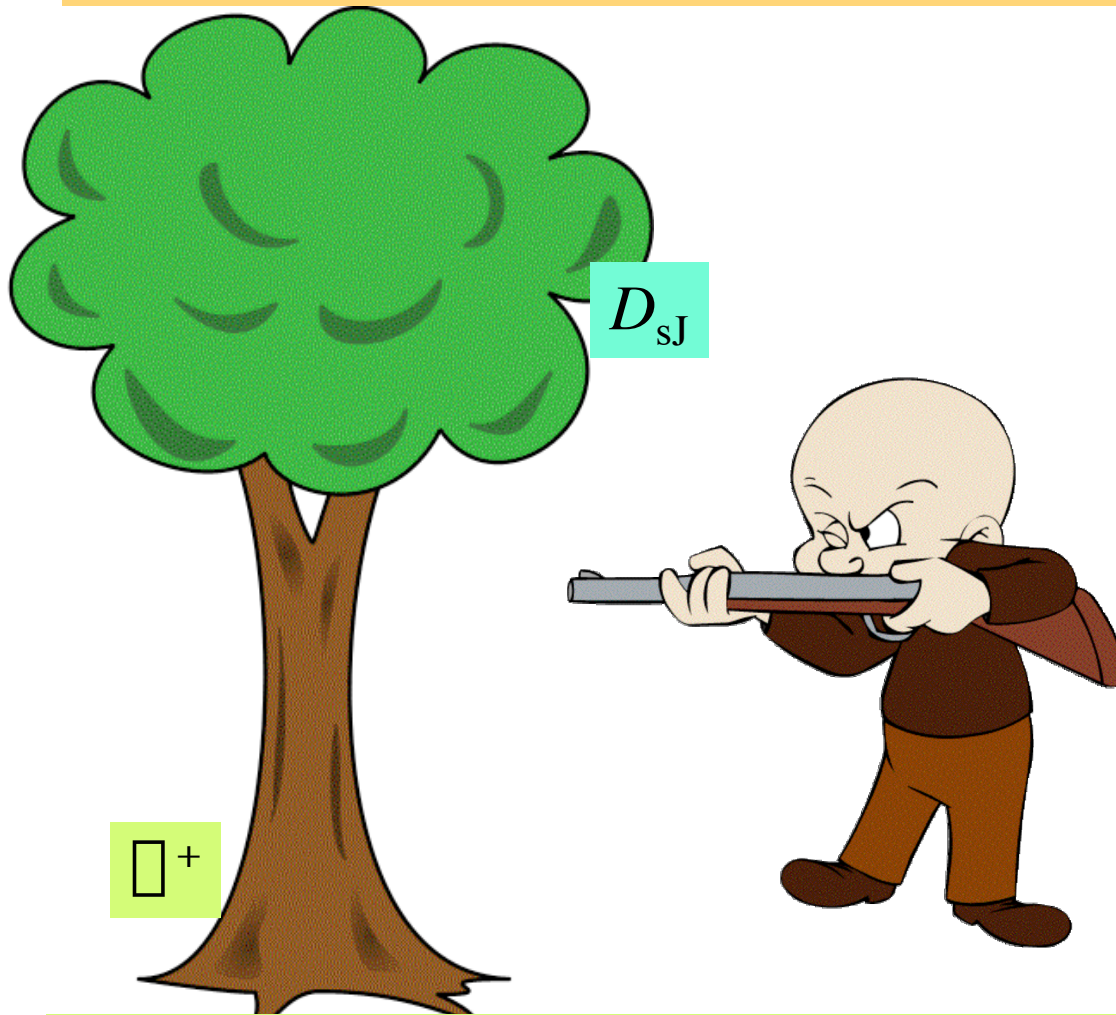
- Competitive with LEP results. Will improve with statistics.
- See talk by Daria Zieminska.

# Rare Decays



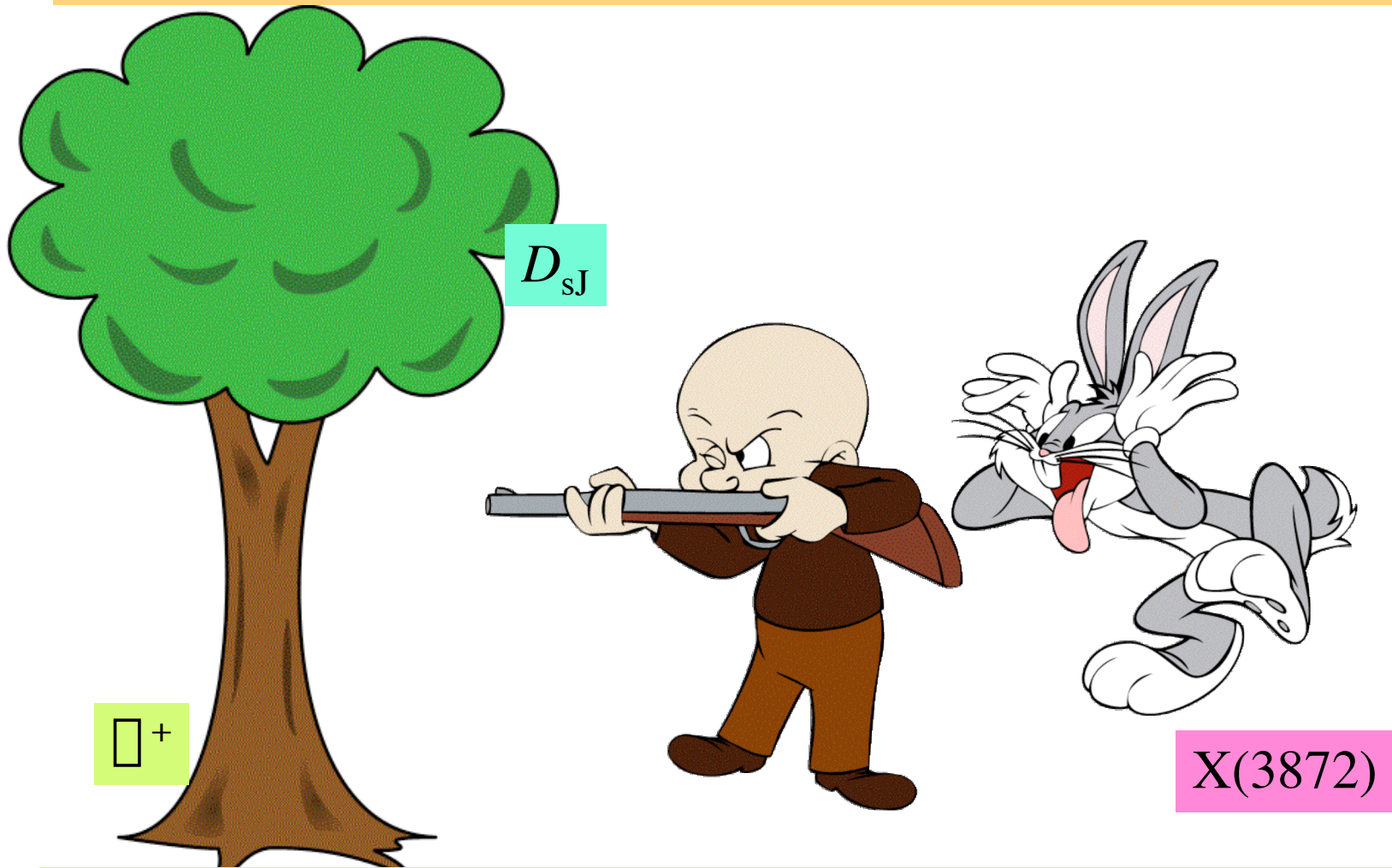
- ☞ New limit for B.R. of  $B_s \rightarrow \mu^+ \mu^-$ :  
 $< 9.5 \times 10^{-7}$  @ 90% CL  
 $< 1.2 \times 10^{-6}$  @ 95% CL
- ☞ Limit on B.R. of  $B_d \rightarrow \mu^+ \mu^-$   
 about a factor of 2 worse than BaBar and Belle.
- ☞ New limit for B.R. of  $D^0 \rightarrow \mu^+ \mu^-$ :  
 $< 2.5 \times 10^{-6}$  @ 90% CL
- ☞ See talk by Cheng-Ju Lin.

# Hunting For New States



- Sssshhhh.....

# Hunting For New States

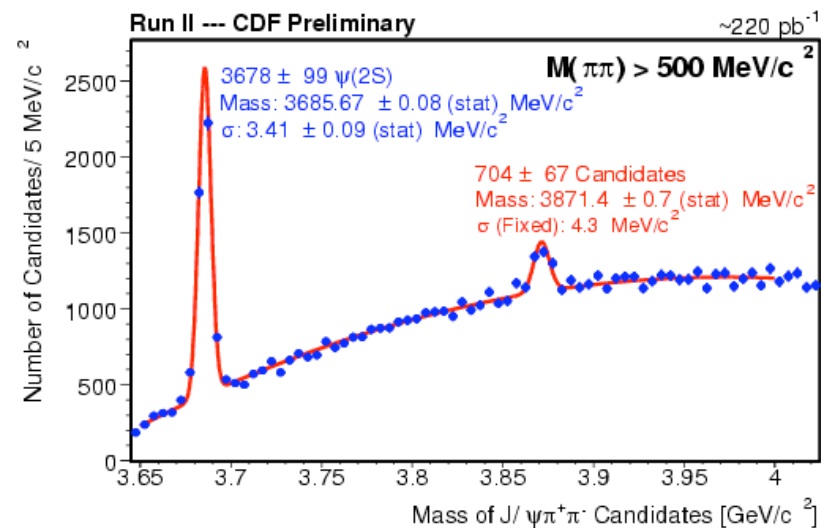
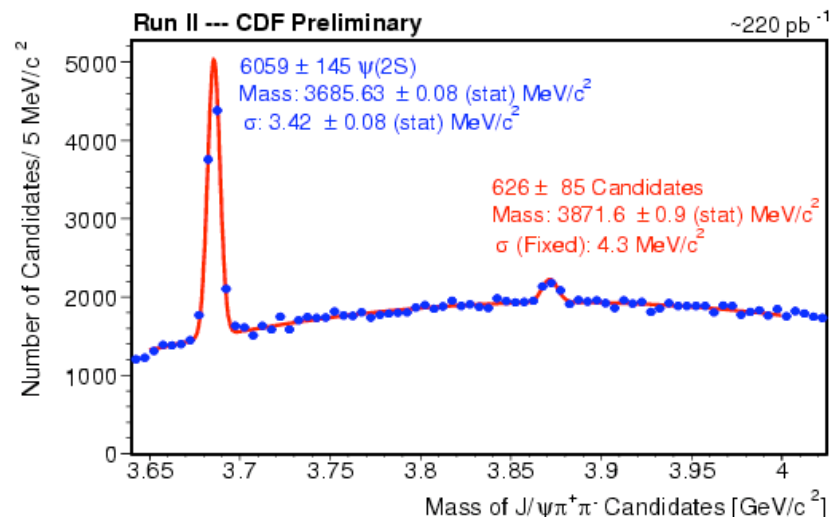


- Ssssshhhh.....Wabbit hunting.



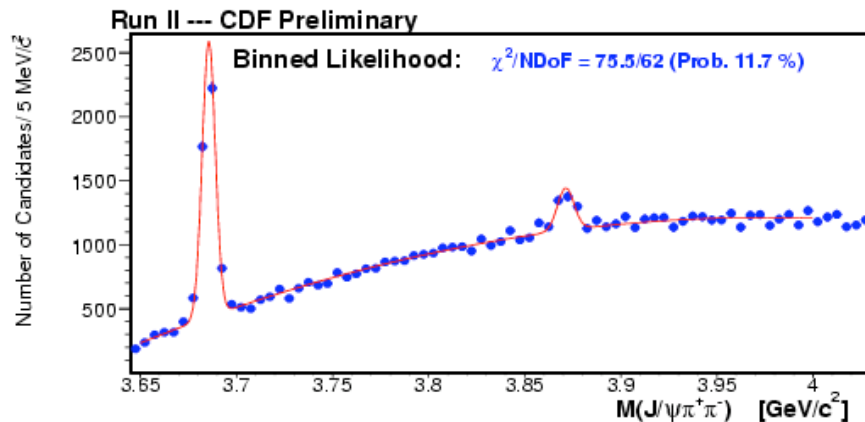
# X(3872)

- ◆ New state observed by Belle in  $B \rightarrow XK \rightarrow J/\psi \psi^+ \psi^- K$  final state of narrow width.
- ◆ Tevatron: this state produced directly, or via  $B$  decays.
- ◆ CDF observes this state at the same mass.
- ◆ Belle reports that  $M(\psi \psi)$  distribution suggests a  $\psi$  resonance.
- ◆ CDF sees a preference for  $M(\psi \psi) > 500 \text{ MeV}$   $\psi$  needs to be finalized!

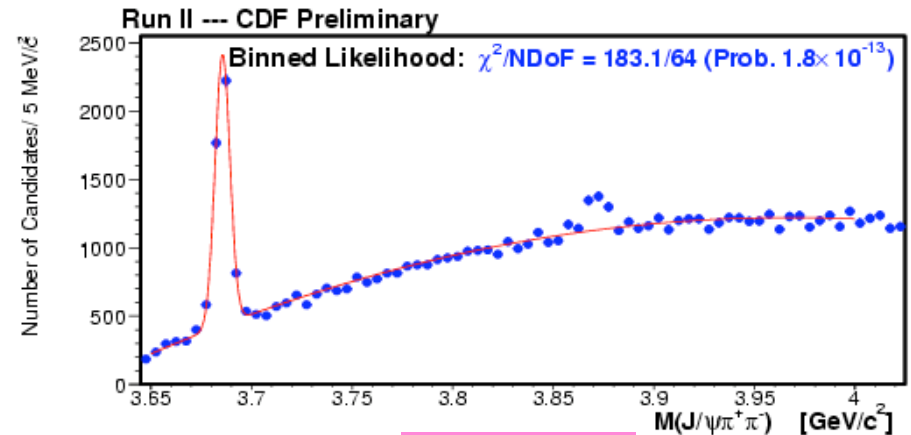




# X(3872) Signal Significance



with



without

- Fit with and without a Gaussian for the X(3872) yields a significance of more than  $10\sigma$ .
- Note relatively large cross section (times branching fraction) compared to the  $\psi(2s)$ .

# What is $X(3872)$ ?

☉ Two leading candidates:

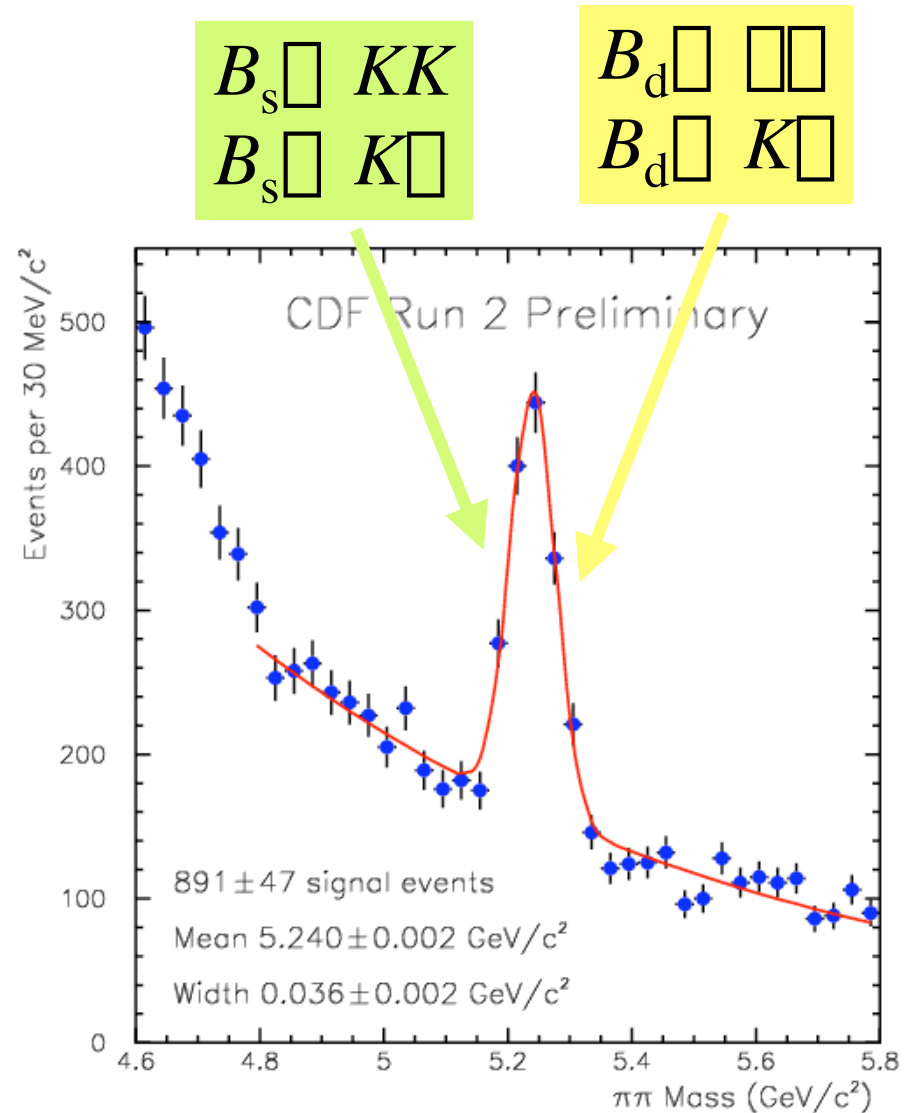
1. A  $c\bar{c}$  state  $\chi$  like the  $1\ ^3D_2$  state
2.  $D^*D$  molecule (suggested by Belle)
  - ◆ Observed mass is a few MeV below threshold
  - ◆  $X\chi\ \chi_c$  is not yet observed by Belle
  - ◆  $X\chi\ J/\psi\ \chi$  forbidden for  $^3D_2$  state

☉ Additional measurements to pin down the quantum numbers:

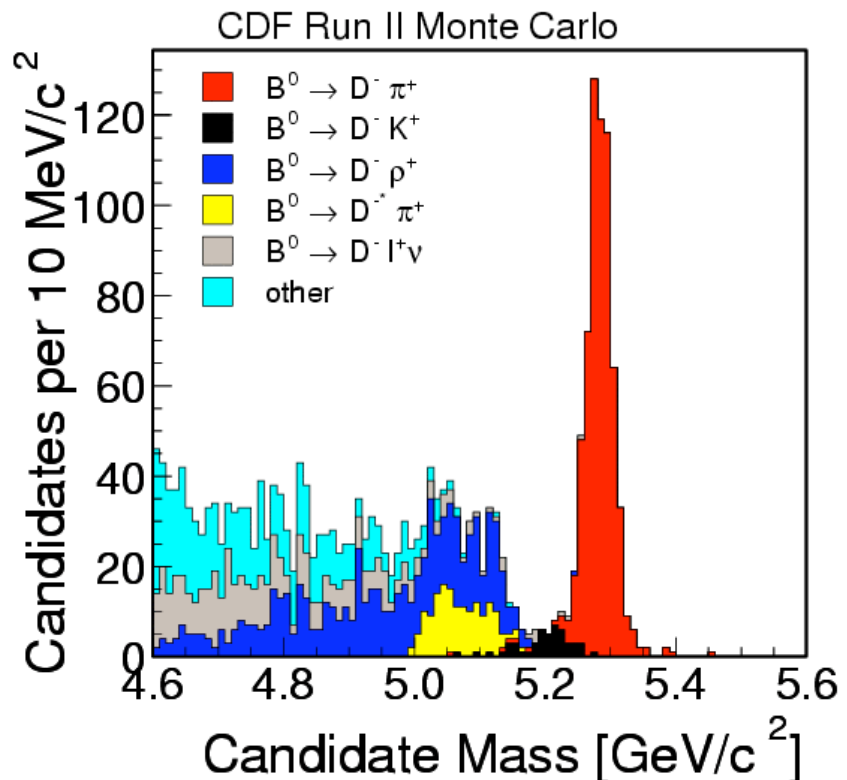
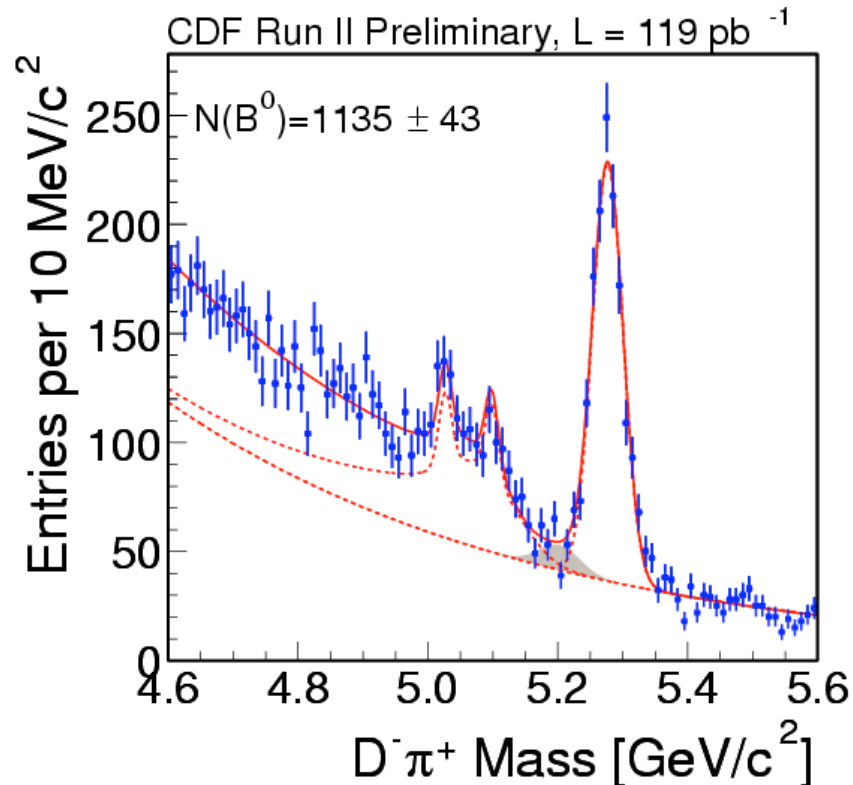
- Helicity angles
- $M_{\chi\chi}$  distribution (resonance structure)

# $B \rightarrow h^+ h^-$ Decays

- $B_d \rightarrow \pi\pi$  and  $B_s \rightarrow KK$  modes are sensitive to CP angle  $\phi$
- $B_{(d,s)} \rightarrow K\pi$  and above modes are separated statistically by kinematics and particle ID.
- $\mathcal{B}(B_d \rightarrow \pi\pi) / \mathcal{B}(B_d \rightarrow K\pi) = 0.26 \pm 0.11 \pm 0.055$ .
- First observation of  $B_s \rightarrow K^+ K^-$

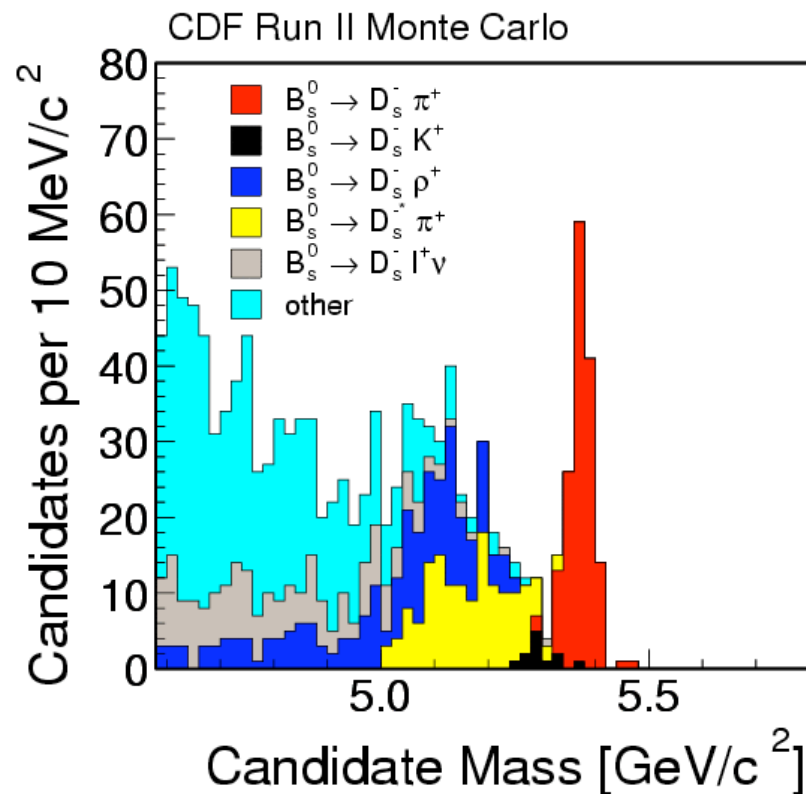
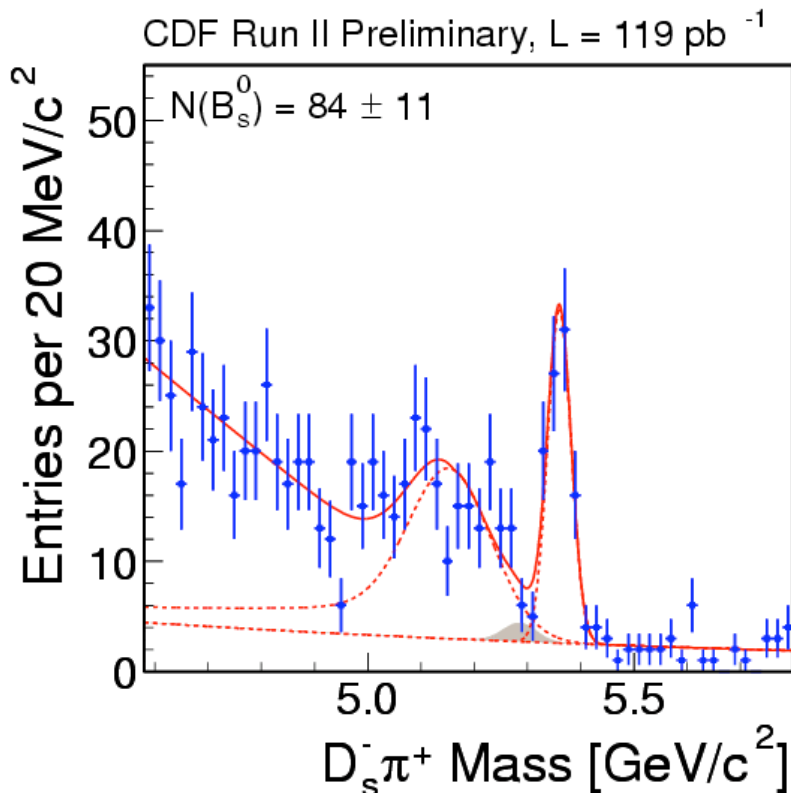


$$B_d \rightarrow D^- \pi^+$$



- MC templates used to fit mass spectrum.
- $B \rightarrow DK$  is another mode of interest for CP analysis.

$$B_s \rightarrow D_s^- \pi^+$$



- ☉  $B_s \rightarrow D_s^- \pi^+$  is a potential mode for measuring  $x_s$ .
- ☉ Fully reconstructed mode for minimal uncertainty in the boost of the  $B_s$ .

# Summary

- 🌀 Progress with CDF Run2 analyses:
  - ◆ Traditional: masses, lifetimes, rare decays.
  - ◆ CDF has observed the  $X(3872)$ .
  - ◆ New topics enabled by the displaced track trigger are being explored: hadronic CP modes, and hadronic modes for  $B_s$  mixing.
- 🌀 New charm and bottom production cross sections □ Chunhui Chen.
- 🌀 Tagging studies □ Ting Miao.
- 🌀 Future prospects □ Petar Maksimovic.